Valuation of a turnover management HRM policy bundle using Monte Carlo simulated real options

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Abstract.

Real options theory is a finance technique used to value alternative paths. In strategic management, real options represent the capacity to respond to uncertain events in the future and this has been examined predominantly from a resource allocation or investment perspective. The field of Human Resource Management (HRM) addresses issues such as staff costs, performance and turnover – all of which have a basis in uncertainty. In this paper we employ GoldSim Monte Carlo simulated real options to value individual and bundles of policies. This form of virtual testing has the advantage of not interrupting operations. GoldSim Monte Carlo simulation offers strategic management and policy makers an experimental method with significant advantages over spreadsheet-based simulation. GoldSim's pictorial interface makes it easier for business people to understand and experiment with simulation models.

1. INTRODUCTION

Real options theory is a finance technique used to value alternative paths. In strategic management, real options represent the capacity to respond to uncertain events in the future and this has been examined predominantly from a resource allocation or investment perspective - for example [9],[11],[13],[19]. The field of Human Resource Management (HRM) addresses issues such as staff costs, performance and turnover – all of which have a basis in uncertainty.

GoldSim is Monte Carlo simulation software used for dynamically modeling complex systems in business, engineering and science. GoldSim supports decision and risk analysis by simulating future performance while quantitatively representing the uncertainty and risks inherent in all complex systems. GoldSim can evaluate and compare alternative designs, plans and policies in order to minimize risks and support better decision making. In this paper we employ GoldSim Monte Carlo simulated real options to value individual and bundles of policies. This form of virtual testing has the advantage of not interrupting operations [14],[17]. GoldSim Monte Carlo simulation offers strategic management and policy makers an experimental method with significant advantages over spreadsheet-based simulation. GoldSim's pictorial interface makes it easier for business people to understand and experiment with simulation models [1],[5],[6],[8].

2. A PROBLEM SITUATION

At 'Company X'[1], an Australian software business, the star sales person leaves with little notice, and this triggers a second departure. Only one sales team member remains - half the minimum staffing required. Management tells us that re-hiring is difficult because 95% of people interviewed are rejected and 70% of hires prove unsatisfactory, typically *after* the 90 day probationary period.

2.1 Uncertainties of Human Assets

To address this situation, we interviewed the long serving CEO and adopted a framework [3],[4] for considering uncertainty in the HR domain - Figure 1. It is important to note that this is far from a complete view. Additional sources of uncertainty are readily conceived of, and readily not-conceived of (for example because they are outside historical experience) [18].

SOURCES OF UNCERTAINTIES			UNCERTAINTIES
INDIVIDUAL	FIRM	MARKET	
Interview	Agency quality	Competition	Supply
Innate capacity Performance cycles Seasonal cycles	Support provided Cannibalism	Nature of product	Performance
Personal issues	Level of investment	Variety	Turnover

Figure 1: Sources of uncertainty in Company X sales staff turnover [4]

3. THE REAL OPTIONS APPROACH

Classes of management options that can be used to address uncertainty in personnel costs, performance and turnover are to be found in the literature [3],[4],[15]. For Company X, three proposed management options are proposed in Figure 2.

UNCERTAINTIES	MANAGEMENT OPTIONS
Supply	Establish pool of staff for call-up at short notice
Performance	Extend probation period to allow replacement if performance is poor
Turnover	Introduce sabbatical policy for long serving staff

Figure 2: Management options in response to uncertainties in the employment of sales staff at Company X

[1] Name withheld

3.1 Real options framing

A full description ('framing') of each real option includes what it costs, when it can be acquired, when it can be taken (exercised), what its effects are and how it compares with other paths. Dependencies between real options must be noted. The exact details of the condition(s) necessary for a decision to exercise each real option must be recorded in order to model management's active participation in the simulation. Each of the inputs to the model and the options must also be closely considered. As has been observed by others – for example [2],[12] - the accuracy of the figures used requires commentary, as do any assumptions underlying the model. Each of the previous options are now framed.

Table 1: Framing of real options to be valued

Option	Offers	Benefits	Acquisition cost	Exercise cost	Action when[1]
A	Contract staff for call-up at short notice	Ability to quickly fill vacant chair	Recruitment Training Retainer	Contract fees for staff	Turnover occurs
B	Ability to fire worker up to six months	Opportunity to hire a high performer	Contract rate worth foregone security	Vacant chair	Poor worker identified
C	Sabbatical for long serving staff person	Likelihood of staying with company longer	-	Lost sales Cost of replacement	Tenure level met

Table 2 outlines the option 'decision triggers' by which management can exercise its options.

Table 2: Decisions to exercise example real options

Assess	Action
If number of salespeople available this month less than the number of chairs	Exercise Option A- introduce casual (incur premium) and initiate recruitment if applicable
If the 6 month average value of the sales person closest to poor (25)	Exercise Option B - fire salesperson and initiate recruitment. (Potential value in triggering Option A.)
If a star performer, and employed 6 months	Exercise Option C - Initiate sabbatical and call up a casual (Option A)

These options have additional 'life term' rules:

- Option B is invalid once a salesperson is permanent
- Option C must be re-earned following each sabbatical

All management decisions of this magnitude are made by the CEO. There is a sales director with authority by virtue of seniority and experience, but it is simply the culture of the organisation that decisions with financial or human impact are brought to the CEO at least for counsel.

3.2 Model assumptions and inputs

The following assumptions have been made:

- Normal distribution has been assumed for all probability distributions.
- The three options are independent of one another – i.e. the employment of new sales people on contract does not affect the inputs or results of sabbaticals.
- Company X aims to have three sales people based on the CEO's logic that this ensures there are two. The number is set by his experience of the Australian market.

Actual numbers input to the model are presented in Tables 3, 4 and 5.

Table 3: Model inputs

Input	Value and Commentary
 DiscountRate	DiscountRate 5% An estimate of the current retail banking interest rate (risk-free and accessible) Used to calculate a present value for future cash flows.[2]
 DelayHire	HireMonths 3mths, HireStdDev 1mth Generated using a normal probability distribution. Based on the CEO's experience of recruitment.
 PerformerHired	ChancePoor 60%, ChanceTypical 30%, ChanceStar 10% Approximated using three personifications of performance points – the 'star performer', 'typical performer' and 'poor performer'. The CEO reports hiring experience has been skewed towards poor performers.

3.3 Sales Performance Inputs

Table 4 details the inputs assigned to each of the three performers - sales return per month as a Net Cash Flow (NCF), the term of employment and volatility of both via Standard Deviations (StdDev). These numbers are derived from actual data from Company X for sales people identified in the three categories.

Table 4: Sales performance types (inputs)

Inputs	Values and Commentary
	StarNCF $64.5, StarNCFStdDev $50 StarTerm 60mths, StarStdDev 36mths Based on historical record of 1 person. Management wants to secure them.
	TypicalNCF $30.5, TypicalNCFStdDev $20 TypicalTerm 36mths, TypicalTermStdDev 24mths Based on historical record of 3 persons. Management wants improved performance.
	PoorNCF $17.75, PoorNCFStdDev $10 PoorTerm 18mths, PoorTermStdDev 12mths Based on historical record of 2 persons. May not be suited to this work.

All financial quantities are in thousands of Australian dollars.

The attraction of this approach is that it is easily understood by management and separates performance levels from the likelihood of them being hired. Research into the hiring and performance experiences of other software and sales companies in Australia should be conducted to support management in determining figures. These figures may also be revised as more is experienced.

3.4 Option Parameters

Each option under consideration has inputs particular to its valuation. These are presented in Table 5. They also have uncertainty associated with them. It would be simple to transform these inputs to stochastic forms but at this stage of evolution of the simulation, it adds a level of complexity that will make buy-in more difficult. Management at Company X is comfortable with their ability to hold the following inputs at fixed values.

Within the model, monthly cash flows such as a monthly retainer or a premium for contractor services can be combined with previously estimated monthly Net Cash Flows (NCFs) for whichever performance type is employed. Clearly management must be included in the assignment of the real option inputs. Apart from their ability to supply accurate information, the exercise of simulating and then experiencing

[2] The discounting of future cashflows acknowledges the opportunity cost when applications of finance are compared with zero-risk alternatives.

reality may assist management in examining assumptions and inputs that have affected the model and are affecting decision making.[16]

Table 5: Real option inputs

Inputs	Values and Commentary
 Option A	CasualRetainer $5 CasualPremium $8 Labour force providers could guide realistic costs. Experienced contractors expected to perform at 'typical' level. Premium is paid on top of remuneration.
 Option B	ContractMonths $6 ContractPremium $2 It is theorized that a candidate could be hired on a trial basis with the premium to justify the delay in receiving the security of permanence.
 Option C	SabbaticalQualify 60mths SabbaticalTerm 6mths SabbaticalCost $2.5 A star performer must qualify for the sabbatical by serving for a minimum term. A sabbatical device is dependent on Option A.

4. SIMULATION MODELLING

GoldSim has previously been used for strategic planning in a number of fields [9]. The options and their parameters presented in the previous section have been modeled using the simulation tool GoldSim – see Figures 3, 4, 5 and 6.

Components are elements that encapsulate other elements and are denoted by symbols that have a 'plus' (+) symbol. Components are 'opened' for examination by clicking on the plus symbol. A significant structural element in the architecture is the use of three duplicate 'chair' components to represent the three positions that aim to be filled and collectively valued. This architecture offers future scaleability. Different strategies could also be applied for Chair 1, 2 or 3.

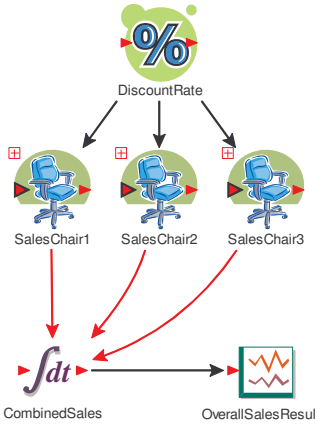

Figure 3: Top level model design.

4.1 Chair component

Each chair encapsulates simulation of performance output from the chair and the terms (durations of employment) of the people that occupy the chair during the period of simulation. The model encapsulates those aspects of each chair in components.

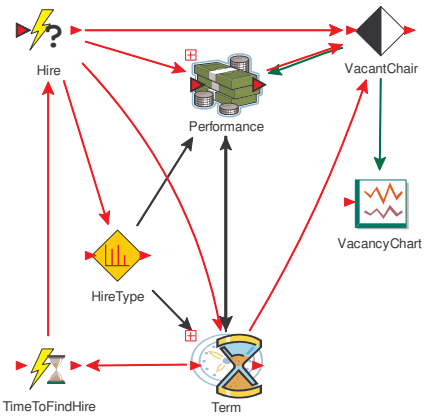

Figure 4: Chair component model design.

Simple probability is applied to each new hire's 'type' of performance and term. The primary event identified here is the hiring event which is triggered by turnover. It is delayed by the time required to find a new hire. A vacant chair flag indicates sales for the chair will be zero.

4.2 Term component

Upon a hire event, a new term must be set according to the hire type and the characteristics of each. This is 'TimeLeft' which decreases each month until at zero, a 'TurnoverDecision' occurs. This represents a major assumption of real options – that management is not passive. Here we see management's response to events built into the model and that opportunity is what will be valued.

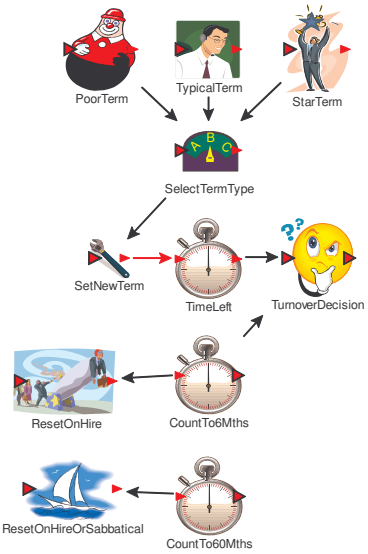

Figure 5: Term component model design.

The design also illustrates elements necessary to support two of the options – a probation counter for Option B and a sabbatical qualification counter for Option C.

4.3 Performance component

Monthly performance is based on sales person type. As per Option A, a vacant chair triggers the use of a contractor (and the cost of their premium monthly rate). Additional elements support Option C's need to keep track of the sabbatical period and Option B's need to determine the new salesperson's performance over the first six months.

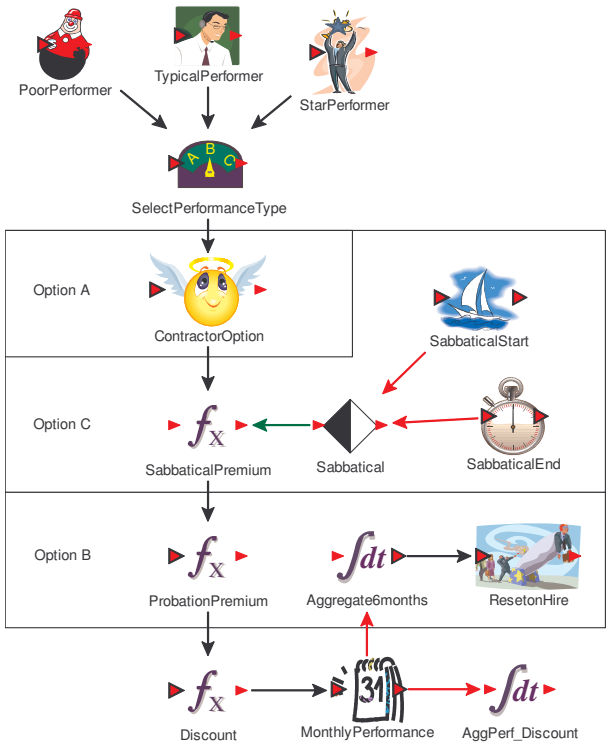

Figure 6: Performance component model design

No leakage of value is modeled. This is a common consideration in real options valuations. It could be that a sales person on sabbatical will lose value, but the opposite can be argued as well – that whilst on sabbatical they will gain new skills, relationships or insights that will be of value on their return [10].

5. VERIFICATION TESTS

Numerous tests were performed to determine whether the calculations were being performed correctly [7]. GoldSim allows data to be collected at any point in the model and charts to be generated. Figure 7 shows the chart that was used to check that the addition of sales value from each chair equaled the combined total (top, blue line).

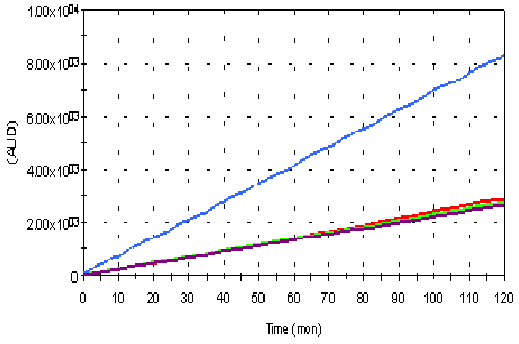

Figure 7: Verification of combined chair values

In Figure 8, the monthly Net Cash Flows (NCFs) from a particular chair in a single realisation of the simulation, are observed being increasingly discounted over time. This test required a 'discounted' (bottom line) and a 'non-discounted' (top line) path to be compared in the performance component.

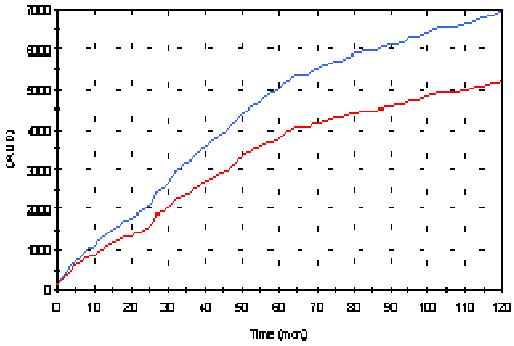

Figure 8: Verification of NCF discounting

Additionally, the mean Net Present Value of an individual chair was compared with figures calculated using a Discounted Cash Flow (DCF) model.

Discounted cashflow model for 'star' salesperson (AUD)

Asset	
Direct cost to acquire (000's)	10
Time to acquire (months)	3
Average term (months)	60
Discount rate	5.00%

Performance	
Monthly sales mean (000's)	80

Net Present Value Calculation				
Month	-2	-1	0	N
Cash inflow				80
Cash outflow - fixed costs			10	5
Cash outflow - commission				10.5
Net cashflow	0	0	-10	64.5
Summary PV	0	0	-10	3418
NPV	3366			

Figure 9: One of three Discounted Cashflow (DCF) models used to verify the terminal value of un-optioned chairs.

Prior to the implementation of Option A, it was important to verify that monthly NCF from a chair was zero if the chair was vacant. In Figure 9, a chart of the performance of a chair is aligned with a chart of the vacancy of that chair. Flat spots in the top chart align with vacancies in the bottom chart.

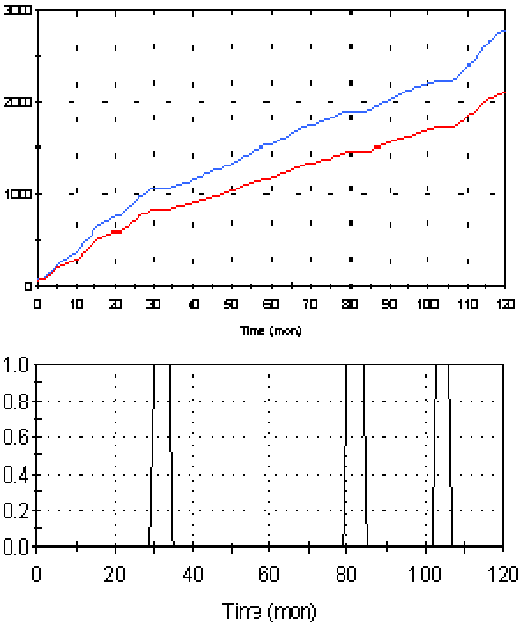

Figure 10: Verification of impact of chair vacancy on NCFs

Finally, evidence was collected to verify that NCFs were indicating the employment of different salesperson types over time. In Figure 10, a poor performer is replaced by a star performer at around the 70th month in a particular realisation of the simulation.

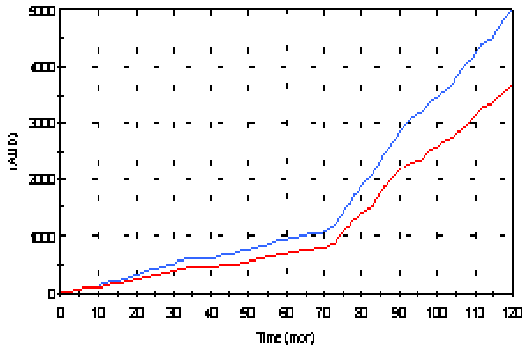

Figure 11: A Star performer is employed

6. OPTION VALUATION RESULTS

In Section 3.1, each option was framed and the decision to exercise described in detail. By valuing the model prior to the addition of any options, we can evaluate the eventuality where such decision is never made – the options are never exercised. It is in comparison with this valuation, that each option will be assessed as being of value or not. Essentially this means each course of action will be contrasted with a 'do nothing' strategy which has its own quantitative characteristics. Each path will also have its own qualitative value that could be of greater importance. We will also observe the value of the combinations of options which may offer unique benefits [11],[12]. On the basis of 1000 realisations, Net Present Value (NPV) for 10 years of sales was simulated for a number of configurations. The runtime on a mid-level AMD dual core PC is 30 seconds for the baseline model and 45 seconds for the model with all three options implemented.

Table 6: Real option valuation results

Configuration	NPV $M	Added Value
Baseline	8.69	
Option A	8.76	0.07
Option B	9.02	0.33
Option A and B	8.93	0.24
Option A and C	9.05	0.36
Option A, B and C	9.30	0.61

All three options add value but they are most effective in combination - adding $610,000 to the value of the sales team, see Table 6. As shown in Table **7, l**ooking beyond mean performance, it appears that the options have improved the likely (+/-25%) sales team valuation in both up and down side scenarios by at least a million dollars.

Table 7: Impact of options on 'nearside' valuation

Configuration	NPV without options $M	NPV with options $M
(Mean)	(8.7)	(9.3)
75th percentile	13.4	15.0
25th percentile	5.0	7.0

Figures 12is a chart of the model with all three options implemented. The chart shows increasingly unlikely ranges of probability in darker shades. It's important to note that, of course, re-simulation produces different results, varying significantly despite averaging over 1000 realisations. The variance seen between runs may be resolved by realisations of 10,000 (or more) simulations. Run time should be under 10 minutes.

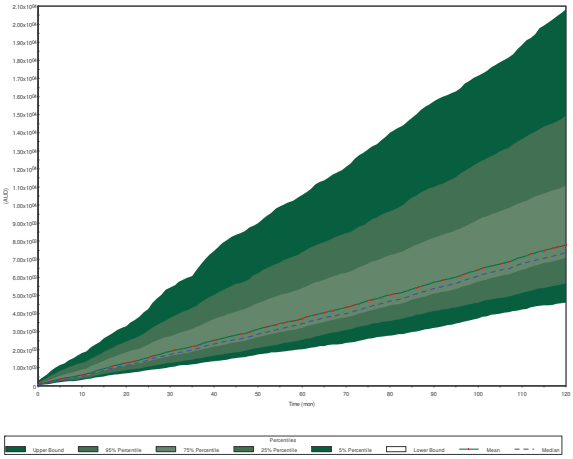

Figure 12: Chart of model NPV with all three options

Note that Option A actually gives rise to Option C without which it would not be possible because a sabbatical would have too great an impact on the business. If Option A is available it is also a natural accompaniment to Option B – in fact to any situation where a chair will be temporarily unoccupied. Therefore it's reasonable to imagine that with further analysis, it will be found that Option A gives rise to many more options. Although it isn't necessary for the purpose of this paper, it should be acknowledged that Option A is of greater value because of the options that it makes possible.

7. CONCLUSIONS AND FUTURE WORK

The results indicate that Monte Carlo simulation is an effective way to value a bundle of HRM policies. GoldSim has proven to be suitable for the application and in particular its pictorial interface is of great assistance in explaining the model. Additionally, the exercise has identified a valid framework for HRM real options which can be generalised to other business functions.

It is now possible for the simulation to be demonstrated to Company X management with the aim of securing buy-in to a second evolution of the model with more rigorously determined inputs and a more complete set of HRM policy options to be valued. It is not expected that simulated option valuations will be used without being combined with qualitative knowledge. Management is aware of the weaknesses of probability, financial theory and simulation. However, option values may be considered as part of the information deemed relevant to decision making if the model and inputs are maintained so as to be capable of timely response.

The following possibilities exist for future work:

- The model could be developed to a more complete state - for instance, an existing option, to fire probationary staff at 3 months, is not incorporated.
- Greater research and analysis can be performed in the determination of inputs to the model. Inputs require detailed examination with validation against external sources. For instance, recruitment industry figures could be used in considering the time required to hire a new salesperson. **Additionally sensitivity analysis can be performed on the model.**

- Greater elegance in modelling and more complete use of the features of the simulation system is to be pursued. Feedback from experienced simulation engineers will be incorporated.
- Threshold values can be sought - for example when can a manager be 99% sure a sales person is a poor performer?
- It is of particular interest to obtain feedback subsequent to this as to how the use of the simulation has influenced management. For instance, does modeling encourage a more strategic view and more pro-active planning for uncertain events?
- With greater analysis given to inputs and model dynamics, it's reasonable to imagine that figures could be derived that would justify the creation of new policy. In continuing to collect data, Company X may be able to support a follow-up analysis of the real-world effectiveness of policies vs. their simulated benefits. Such analysis would represent validation of the approach.
- A range of unusual options could be examined in this context. For instance, what if the firm put a value on customer-salesperson relationships. How might this affect hire-fire dynamics? Topics to explore include alternative sources of sales staffing, non-financial (intrinsic) motivation for sales people, alternative tiers for commissions, the value of training and motivation activities and the use of more detailed performance incentives for recruitment agents that refer to the speed of candidate presentation and the term of their employment.
- Normalisation of sales data to produce more accurate inputs for salesperson performance. The chart in Figure 13 appears to show seasonal sales highs at the end of each financial year.

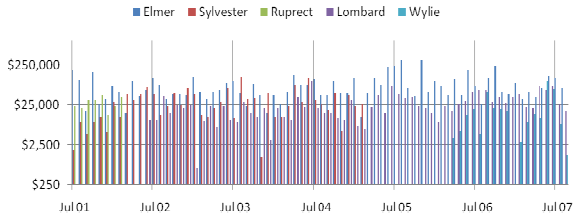

Figure 13: Chart of Company X monthly sales using a logarithmic scale

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